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DRAFT Brief Description of Catalog Items

Agriculture, Forestry, and Waste (AFW) Including Water Management

Multi-Sectors Technical Workgroup – 3 of 4

This document provides brief descriptions of the policy options contained in the corresponding AFW Catalog of Policy Actions. The catalog and these brief descriptions will be developed more fully during the project planning process.

AFW-1. PRODUCTION OF FUELS AND ELECTRICITY IN AGRICULTURE AND FORESTRY

1.1 Expanded Use of Biomass Feedstocks for Electricity, Heat, and Steam Production

Increase the amount of biomass available from forests for generating electricity and displacing the use of fossil energy sources. Growing more biomass on a shorter rotation and/or more perennial crops can increase carbon uptake in plants. If biochar is a by-product and incorporated into the upper horizon of soils, carbon sequestration is increased. Note: This is related to Option 9.2: Expanded Use of Municipal Solid Waste and Yard Waste Biomass Feedstocks for Electricity, Heat, and Steam Production option.

1.2 In-state Liquid Biofuels Production

Increase production of ethanol, biodiesel, or other liquid/gaseous biofuels from agriculture and forestry feedstocks (raw materials) to displace the use of fossil fuel. For example, promoting the development of cellulosic ethanol feedstocks and production systems that use renewable fuels lower the embedded carbon content of ethanol. Increased production and consumption in-state biofuels will likely provide the highest benefits.

Growing more biomass on a shorter rotation and/or more perennial crops can increase carbon uptake in plants. If biochar is a by-product and incorporated into the upper horizon of soils, carbon sequestration is increased. Note: This is related to Option 9.8: Waste Management Feedstocks for Liquid/Gaseous Fuels Production option.

1.3 Improved Energy Capture from Wood Waste and Biomass Combustion

Reduce emissions and increase heat efficiency from bio-feedstocks and heat sources such as wood burning stoves and furnaces and using pyrolysis ovens. Continue to advance the biomass heating industry.

1.4 Improved Commercialization of Biomass Conversion Technologies

Improve the rate of technology development and market deployment of biomass conversion technologies including biomass gasification combined cycle (BGCC), pyrolysis, and plasma arc technologies. These technologies expand the application of renewable fuels derived from biomass. A range of renewable products can be developed from these processes, including gaseous and liquid fuels, biochar, chemical products, and methane to methanol. Existing processes include waste combustion and energy recovery (as electricity, steam, or both) or ethanol plants using co-products for heating and drying, rather than relying on outside energy sources. This is beneficial for sequestration as it relates to the production and expanded use of biochar.

1.5 Integrated Bioenergy Research and Production

Integrate electricity from anaerobic methane digestion of manure, with production of by-products, e.g. biodiesel and ethanol. Pyrolysize biomass to create energy and by-products, e.g., syngas, bio-oil and biochar.

1.6 Expanded Production/Use of Bio-based Materials and Chemicals

Expand the production and use of bioproducts such as corn-based plastics through applied research, expanding production and markets. Increase the amount of renewable products and chemicals produced from bio feedstocks, including building materials that reduce GHG emissions over conventional petroleum-based products.

1.7 Installation of Manure Digesters

Reduce the amount of methane emissions from livestock manure by installing manure digesters on livestock operations. Energy from the manure digesters is used to create heat or power, which offsets fossil fuel–based energy production and the associated greenhouse gas (GHG) emissions. May consider new technologies as well, such as plasma arc technology.

Integrate methane digesters into agricultural operations to generate energy from waste on an individual or community basis.

1.8 Installation of Community Digesters

Community digesters can utilize multiple waste streams to produce biogas that can be used as a fuel. Thermophilic anaerobic digestion utilizes manure, food residues, crop residues, yard wastes, organic fraction of municipal solid waste, and sewage sludge. The effluent produced can be used as an agricultural soil amendment. Utilizing drier feedstock creates a higher biogas yield and allows for a more stable digestion process that requires less mixing and disposal of wastewater.

AFW-2. AGRICULTURE—LIVESTOCK

2.1 Manure Management—Manure Utilization as Soil Additive

Implement manure management practices that reduce GHG emissions associated with manure handling and storage. Potential practices include but are not limited to manure composting (to reduce methane emissions), manure crusting, addition of additives to decrease the amount of nutrients lost and improved methods for application to fields (for reduced nitrous oxide [N_2O] emissions). Application improvements include incorporation into soil instead of surface spraying or spreading.

2.2 Manure Management—Methane Capture from Manure

Implement digester and energy recovery projects at confined animal feeding operations (CAFOs) both to reduce methane emissions and to utilize the energy to displace fossil fuels. (To date, most of these projects have been implemented at dairies and swine operations.)

2.3 Manure Management— Biofilter use at Confined Animal Feeding Operations (CAFO)

The utilization of collection and control equipment such as bio-filters at CAFOs can reduce methane emissions.

2.4 Manure Management—Lower Density Pasturing to Decrease Emissions from Manure

Increasing the area over which manure is deposited has the potential to reduce emissions of methane, since the manure is more likely to be decomposed aerobically than anaerobically.

2.5 Changes in Animal Feed to Optimize N_2O Reduction

Livestock emit methane directly as a result of digestive processes (enteric fermentation). Research suggests that changes in the energy content of feed and other dietary changes can reduce methane emissions from enteric fermentation. By optimizing nitrogen (protein) utilization in the feed, nitrogen levels in the manure can be reduced, which in turn reduce the potential for nitrous oxide emissions.

AFW-3. AGRICULTURE—CROP PRODUCTION

3.1 Soil Carbon Management

On managed land, the amount of carbon stored in the soil can be increased by the adoption of practices such as conservational residue management and tillage (e.g., mulch tillage, reduced-tillage, no-till cultivation, etc.), crop diversity and crop rotation. Reducing summer fallow and increasing winter cover crops are complementary practices that reduce the need for conventional tillage. By reducing mechanical soil disturbance, these practices reduce the oxidation of soil carbon compounds and allow more stable aggregates to form. Other benefits include reduced wind and water erosion, reduced fossil fuel consumption for management purposes, and improved wildlife habitat.

Improved agricultural practices can often increase soil carbon sequestration; however, native vegetation and natural ecosystems are generally most effective at storing and sequestering carbon.

Encourage soil productivity and carbon sequestration through the use of biochar, particularly on agricultural land. The application of biochar increase soil carbon content, stabilizes soil carbon, provides microbial habitat, and attracts and holds moisture and nutrients, making both more bio-available to plants.

3.2 Nutrient Management

Improve the efficiency of fertilizer use and other nitrogen-based soil amendments through implementation of management practices and Generally Accepted Agriculture Management Practices (GAAMP). Excess nitrogen not metabolized by plants can leach into groundwater and/or be emitted to the atmosphere as N_2O. Better nutrient utilization can lead to lower nitrous oxide emissions from runoff. Maintaining higher nutrient levels in the soil (decreased leaching and run-off) increases plant growth.

3.3 Technology Improvements to Increase Efficiency

New technologies and cultivation methods have the potential to reduce GHG emissions when fossil fuel or electricity consumption can be reduced. Auto-steer guidance systems are an example as is auto swath technology, which uses global positioning system (GPS) to automatically turn the spray boom sections on or off when coming to an area of the field that has been sprayed or needs to be sprayed. Auto swath technology can be used for planting, fertilizing, and other operations. On odd-shaped fields, it can result in a 3%–5% savings. See http://www.agleader.com/products.php?Product=directcommand_1

GreenSeeker normalized difference vegetation index (NDVI) technology. This is a new technology that is still in its early testing stages, but it looks promising. See http://www.ntechindustries.com/greenseeker-RT200.html, A farmer applies 50%–70% of his nitrogen at planting and then, in season, uses GreenSeeker to apply what the corn or wheat plant needs when it is growing—a more efficient way of applying nitrogen that will result in less nitrogen being over-applied.

Improvements may also encompass newer machines with better fuel efficiency, larger planters and combines, and genetically modified seed.

3.4 Biotechnology Applications for GHG Mitigation

Improved research in and utilization of drought-resistant, flood-resistant, pest-resistant crop varieties. Biotechnology could lead to the introduction of plants with a greater uptake of carbon throughout their lifecycle.

3.5 Perennial Crop Production

Encourage the planting of perennial crops that reduces tillage, reduces planting costs and related equipment use and soil compaction, and typically reduces water consumption. Perennial crops also increase the level of soil carbon as opposed to annuals and the associated cropping techniques requiring greater ground disturbance and compaction. Perennial crops can include those grown for human consumption, animal feed or for biomass.

3.6 Irrigation Improvements

Drought and uneven distribution of annual precipitation continue to threaten rain-fed agriculture, especially in arid and semiarid regions. It has been proven that irrigation can significantly increase crop yields and consequently enhance soil organic carbon accumulation due to reduced soil erosion and increased biomass production. Energy efficient irrigation systems and appropriate water conservation need to be partnered with this recommendation because of their effects on greenhouse gas mitigation and adaptation respectively.

3.7 Drainage Management

Improve drainage on agricultural lands to prevent ponding, which could lead to anaerobic soils and GHG emissions (methane). Ponding reduces the ability of soils to sequester carbon and to grow plants. Conversely, draining of hydric soils, organic soils and peatlands has been shown to reduce soil carbon, which in some instances could be offset by increased crop production. Consequently, this option is limited to reducing ponding.

3.8 Improved Efficiency of Nitrogen Through Soil Sampling

Variable rate fertilizing and liming are also becoming more popular among farmers. The farmer has a local co-op grid-sample the field, and then variable rate applies the fertilizer or lime in the areas of the field that need it. The areas of the field that do not need fertilizer or lime have none applied, which can result in a 50%–60% reduction in the amount of lime or fertilizer needed. See http://www.agleader.com/products.php?Product=directcommand_g

3.9 Improve Water Use Efficiency in Agricultural Production

Improve the efficiency of water use through implementation of Best Management Practices and Generally Accepted Agricultural Management Practices. Excess water can lead to nitrogen runoff with subsequent emission to the atmosphere as N_2O. By managing and improving water consumption and nutrients spread on crops, there will be a minimal loss of carbon from the soil. Reduced water consumption can result in lower energy use for water pumping.

AFW-4. AGRICULTURE AND OPEN SPACE—OPTIMIZATION OF LAND USE

4.1 Improved Vegetation on Marginal Lands

There are several ways to enhance carbon sequestration in marginal lands: (1) reclaim these lands with native vegetation appropriate to the habitat type; (2) convert marginal agricultural land used for annual crops to permanent cover—such as grassland/rangeland or forest; (3) continue to implement the Conservation Reserve Program (CRP), and/or (4) encourage development of biomass-oriented production system such as planting with switchgrass, miscanthus, mixed grass species, etc. Marginal lands can include under-productive agricultural lands, easements, highway rights-of-way, under-vegetated lands, etc.

4.2 Land Use Management that Promotes Permanent Cover

Adopt mechanisms to prevent conversion of native prairies and highly functioning ecosystems. Once converted to croplands for biomass production, protect these acres from returning to annual crop production or to suburban/urban development. Economic factors such as increased demand for corn-based ethanol and biodiesel feedstocks can act as incentives for converting grassland to cropland.

4.3 Mine Land Reclamation

Rehabilitation and reclamation of lands have a great potential to sequester atmospheric carbon into vegetation and soil through plantation or preventing erosion by other developments.

4.4 Preserve Agricultural Land

Reduce the rate at which agricultural lands are converted to developed uses, while protecting private property rights and responsibilities. This retains the above- and belowground carbon on these lands, as well as their carbon sequestration potential. Transportation emissions will be reduced indirectly through more efficient development and lower vehicle use. Agricultural land conversion may be prevented through conservation land grants and conservation easements facilitated through nonprofit land preservation organizations.

4.5 Preserve Open Space / Wildlands

Reduce the rate at which open lands and wildlands are converted to developed uses, while protecting private property rights and responsibilities. This retains the above- and belowground carbon on these lands, as well as their carbon sequestration potential. Transportation emissions will be reduced indirectly through more efficient development and lower vehicle use. Wildlands conversion may be prevented through conservation land grants and conservation easements facilitated through nonprofit land preservation organizations. Public lands can be assigned protective designations (Research Natural Area, Areas of Critical Environmental Concern, Outstanding Natural Areas, Wilderness, etc.) for curtailing conversion to developed uses.

4.6 Prioritize Environmental Remediation Actions GHG Benefits

Place higher priority on reclamation and remediation actions that improve the uptake of carbon dioxide and reduce greenhouse gas emissions such as re-vegetation of disturbed sites with site-appropriate cover crops or native vegetation.

4.7 Preserve and Expand Wetlands for Carbon Sequestration

Implement the Wetland Restoration Program (WRP) and/or similar local programs to preserve and restore wetlands to improve biodiversity conservation and improve carbon sequestration. Recognize that some wetlands can become anaerobic and contribute methane to the atmosphere.

AFW 5. AGRICUTLURE—FARMING PRACTICES

5.1 Increase On-Farm Energy Production and Efficiency

Renewable energy can be produced and used on-site at agriculture operations. For example, installing solar or wind power; using hydro-powered generators for irrigation; converting diesel farm equipment to liquefied natural gas (LNG), compressed natural gas (CNG), or hybrid technology; increasing on-farm use of biofuels and other renewables; expanding farm energy audit programs; and updating machinery, equipment, and engines will reduce carbon dioxide emissions by displacing the use of fossil-based fuels. Installation of equipment with greater efficiency consumes less fuel for agricultural uses.

5.2 Organic Farming

Promote organic farming for its lower intensity practices and non-use of pesticides and fertilizer which can off-gas greenhouse gasses. The emphasis on adding carbon-rich compost to soils and less tillage result in higher soil carbon.

5.3 Programs to Support Local Farming/Buy Local Programs

Promote the production and consumption of locally produced agricultural goods, including transportation and heating fuel and plastics, which displace the consumption of those transported from other states or countries. GHG reductions occur from reduced transportation-related emissions.

Encourage increased beneficial agricultural uses and buying local programs to meet food needs of residents and institutions. Increases demand for local foods and bioproducts that could put underutilized lands such as vacant lots and small acreages into active crop production. Converting native ecosystems to production would offset any potential carbon gains and is not recommended.

5.4 Promotion of Farming Practices that Achieve GHG Benefits

Provide incentives to farmers for using production processes that achieve net GHG benefits. Some practices may include no-till cultivation, reduced tillage, fewer chemical inputs, winter cover crops, etc. For example, by using biotech crops or some organic farming practices that could achieve reduced GHG emissions compared with conventional farming, depending on the specific practices implemented (e.g., use of no-till cultivation and fewer chemical inputs).

5.5 Increase use of Compost in Agriculture

Utilize soil additives derived from organic waste to enhance carbon storage in soil and improve agricultural production. This option can be used in parallel with other policies: community digesters that produce soil additives; manure management; residential composting and organics management programs.

AFW-6. RANGELAND MANAGEMENT

6.1 Improve Rangeland Management

The greatest source of anthropogenic losses of soil carbon on rangelands is poor grazing management. Excessive harvest of plant biomass by livestock and wildlife can lead to diminished productivity. Chronic overgrazing can lead to loss of cover and accelerated erosion, increasing carbon losses and decreasing potential for future storage. The most important aspect of grazing management is proper stocking rate, followed by proper distribution in space and time. Controlling harvest/consumption insures that the optimum amount of photosynthetically active plant tissue is available to fix atmospheric carbon. Management systems using light to moderate stocking rates with sufficient flexibility to respond to year to year variability and achieve desired spatial distribution of grazing pressure are proven to be sustainable. Wildlife use of the same rangelands must be factored into range management systems.

Allowing livestock and wildlife to disperse over larger areas and/or keeping them from concentrating in prime vegetation zones such as lowlands and riparian areas is key to ensuring healthy range conditions and thriving plant populations. Appropriate herding, location of watering sources, distribution of salt and mineral supplements, seasonal timing of grazing and assessment of range readiness may help increase carbon sequestration in plants and soils and improve overall range health.

6.2 Drought Response

A ubiquitous feature of rangelands is drought. While there is little that management can do to completely offset drought impacts, rapid response to drought (reducing grazing pressure) can limit carbon losses and increase the rate of recovery. Management improvements in this area involve the use of alternative forage sources (i.e. grass banks, complimentary pastures) and financial flexibility that can accommodate destocking.

6.3 Restoration of Degraded Rangelands

Historically, overgrazing and drought have interacted to degrade arid (< 250 mm annual precipitation) rangelands. Ecological and economic inertia have constrained the ability of these ecosystems to recover naturally and substantial carbon losses are occurring as exposed soils are further disturbed by wind and water erosion. Currently, there are few, if any, viable technologies for the economically viable restoration of these lands. New technologies and methodologies could reduce the losses and increase carbon sequestration potential. Additionally, many areas of rangeland are threatened by invasive species, both native and exotic, and are in need of restoration-type management practices to reverse undesirable trends. Many of these practices require substantial economic input and the exclusion or limited use of livestock grazing post-treatment.

6.4 Improve Grazing Crops and/or Management

Ensuring pasture vegetation is high in nutrition, resilient to grazing, self-reseeding and vigorous will increase the carbon sequestration potential of soils and plants in grazing systems. Diversifying livestock types and ensuring that breeds are appropriate for the climate and vegetation will also improve utilization of grazing crops.

6.5 Mitigation of Carbon Emissions from Rangeland Wildfires

Naturally occurring wildfires at historic frequencies and intensities are important for maintaining rangeland health. However uncharacteristically severe wildfires can cause significant emissions and lower the soil carbon sequestration potential for some time. Programs to reduce the potential for uncharacteristically severe wildfire will help vegetation and soil to sequester carbon and resist invasion by less desirable, and more fire prone vegetation such as mesquite and cheat grass.

6.6 Increase Carbon Sequestration on Working Rangelands

Rangeland soils are a significant repository for carbon. Proper management can insure that soil carbon remains in those pools in the face of disturbance and that range vegetation continues to thrive. Even though sequestration potential is relatively low per acre, the vast extent of rangelands suggests that policies and programs to incentivize practices to increase carbon storage could have substantial benefits.

AFW-7. FORESTRY—BIOMASS PROTECTION AND MANAGEMENT

7.1 Forest Protection—Reduced Clearing and Conversion to Non-Forest Cover

Reduce the rate at which existing forests are cleared and converted to developed uses. Much of the carbon stored in forest biomass and soils can be lost as a result of such a land-use conversion. Likewise reducing road-building in forested environments increases effectiveness of habitat, allowing for dispersal of wildlife on greater acreage and maintains overall forest cover and health. Easements can be used to protect forest cover as well as conservation programs and wildlands protection designations.

7.2 Reforestation of Understocked Forest Land

Re-establish trees at appropriate spacing on managed forested land that is currently understocked, while minimizing soil disturbance. Interplant stands that are currently thinner than carrying capacity to increase biomass and diversify age classes. Avoid planting monocultures to minimize the risk of insect and disease while increasing the habitat value for wildlife and improving the capacity for biodiversity conservation. Favor the planting of native trees appropriate to habitat type and local climate conditions. Consider future climate trends and plant species most able to adapt and thrive over changing conditions, and species that will maintain or enhance wildlife habitat and water conservation.

7.3 Afforestation and/or Restoration of Non-Forested Land

Establish forests on land that has not historically been forested due to human activities (e.g., agricultural land, mine sites); this practice is called afforestation. Promote forest cover and associated carbon stocks by regenerating or establishing forests in areas with little or no present forest cover; this is known as reforestation. In addition, implement practices such as soil preparation, erosion control, and stand stocking to ensure conditions that support forest growth. Recognize that afforestation of non-forested ecosystems (e.g., prairies, savannas) can cause a loss of soil carbon and disruption of wildlife habitat and other ecosystem services.

7.4 Sustainable Forest Management for Carbon Sequestration

Forest management activities that promote forest productivity and increase the rate of carbon sequestration in forest biomass and soils and in harvested wood products are promoted. Practices include increased stocking of poorly stocked lands, age extension of managed stands, thinning and density management (uncertain carbon benefits), non-fossil fuel-based fertilization and waste recycling, expanded use of genetically preferred species, modified biomass removal practices, fire management and risk reduction, and pest and disease management.

A full life-cycle assessment of proposed activities is recommended to avoid unintended consequences of increased energy use, increased GHG emissions and other deleterious effects which may offset any carbon sequestration gains.

7.5 Mitigation of Forest Carbon Sequestration Loss and Emissions Due to Wildfire

Forest regrowth and fire suppression have resulted in a net sink of US forested lands for CO_2 since the mid-1900s. However, wildfires still remain a challenge to carbon sequestration, particularly in fire-prone forests of the western US and Alaska.

Naturally occurring wildfires at historic frequencies and intensities are important for maintaining forest health and long-term carbon sequestration. However uncharacteristically severe fires can cause significant emissions and lower the soil carbon sequestration potential for some time. Programs that reduce the potential for and severity of uncharacteristically intense wildfires can lower the forest carbon lost during the fire in addition to the subsequent losses of carbon sequestration potential in the area impacted by wildfire.

Prescribed fires may increase carbon in soil if appropriately planned and executed and forest overstory is maintained. Mechanical removal of fire-prone biomass may provide sources of biomass that can be used for conversion to energy while reducing the risk of intense wildfires. Particularly important are biomass-to-energy systems, such as pyrolysis, that capture process CO_2 emissions and carbon in biochar.

7.6 Improve Wildfire Surveillance and Monitoring

Mitigate forest damage due to severe wildfires through improved surveillance and monitoring. Increase the number of monitoring stations on private lands. Encourage private landowners to increase surveillance in private forests.

7.7 Mitigation of Forest Loss Due to Insects and Disease

Programs that reduce insect damage to forests also reduce GHG emissions by maintaining the carbon sequestration achieved in healthy forests.

7.8 Silvicultural and Technology Improvements

Adoption of water conservation, improved harvesting technology such as improved equipment, and other GHG-reducing agricultural practices that can be applied to silviculture. Maximize compliance to programs.

7.9 Wildlife Management to Encourage Vegetative Regeneration and Growth

Overpopulations of ungulates (e.g. deer and elk), porcupines and other wildlife that consume or injure young tree and shrubs can have a significant impact on regeneration and riparian (streamside and wetland) vegetation. Measures to effectively control populations and avoid concentration of animals in sensitive locations can allow regeneration and growth of important species, thus increasing the above-ground biomass and its ability to sequester carbon.

New studies suggest that because of trophic cascade effects of reintroducing top predators (especially wolves and cougars) undergrowth and riparian vegetation is significantly improved in growth rate and coverage. Predators keep wild ungulates more wary and cause them to move more frequently, reducing the concentrated impacts of continual grazing. Wildlife numbers, particularly in ungulate populations, are somewhat reduced which also decreases the impact of browsing on emerging vegetation. Overall biodiversity is significantly increased improving the vegetative health and resiliency of wildlands.

7.10 Vegetation Management to Increase Woody Matter and Succession

Lands where current practices maintain grass and shrub communities in early seral stages and can be managed to encourage the re-conversion and natural succession towards native shrub and forest, respectively. Notwithstanding the role of fire and natural ecosystem disturbances, manage these lands to move into and favor mid to late seral stages.

Encouraging vegetation types with a higher degree of woody matter (i.e., stems, cambium, basal area, etc.) is a large source of potential annual carbon sequestration, and can be assisted by the planting and restoration of floristically diverse, biophysically appropriate species. The ecological context for this management action will be important to consider, as well as balancing the role of wildland fires and the other ecosystem services provided by early seral communities including soil carbon sequestration, wildlife habitat and livestock forage.

7.11 Public Investment to Purchase Forests and Woodland

Encourage public financing of forest and woodland protection. Forest acres close to urban or suburban areas that are mostly likely to be developed have the most to be gained from protection. Much of the carbon stored in forest biomass and soils can be lost as a result of land development.

AFW-8. FORESTRY—WOOD PRODUCTS AND WASTE

8.1 Improved Mill Waste Recovery

Improve treatment and cleaning of waste materials from paper mills, which can then be reused to manufacture additional wood products instead of being burned or land-filled. Sequestering carbon in durable wood products enhances carbon storage. Ensure that sawmill by-products are recycled or beneficially used for energy. Promote opportunities for using mill CO_2 emissions to create chemical products, such as carbonates or syngas. Note: this option links to Options 1.1: Forestry and Agriculture Biomass to Energy and 1.3: Improved Energy Capture from Wood Waste and Biomass Combustion.

8.2 Improved Logging and Other Residue Recovery

Use more efficient, sustainable logging methods to fully utilize harvested trees, which will minimize carbon losses from wood damaged during harvesting and maximize the potential for carbon sequestration in harvested wood products. Process the logging slash and debris efficiently to minimize waste, while ensuring appropriate levels of woody biomass remain on-site to replenish soil nutrients.

8.3 Expanded Use of New, Reused, and Recycled Wood Products

Increase the amount of renewable wood products used for residential and commercial building. Using wood products in place of other building materials can increase carbon sequestration in wood products and displace GHG emissions associated with processing high-energy input materials such as steel, plastic, and concrete. Encourage certification programs, such as Leadership in Energy and Environmental Design (LEED) to put wood on an equal footing with other materials.

Promote utilization of recycled or reusable wood products to reduce wood waste and extend sequestration benefits in manufactured wood products. Reversion to wood as the preferred material for items that are now made of plastic and metals likewise increases sequestration while reducing other carbon life-cycle impacts.

Additional benefits are achieved by promoting the use of locally grown wood for building and products because it has lower transport-associated emissions.

8.4 Promote In-State Forestry Products

Promote the production and consumption of locally produced forestry goods, which displace the consumption of those transported from other states or countries. GHG reductions occur from reduced transportation-related emissions. This practice could encourage better utilization of land for tree growth and increase the value of forests lands, which in turn, could slow and reduce the number of acres converted to development.

8.5 Expanded Markets for Insect-Damaged Wood

Promote use of damaged wood that would otherwise be discarded. Insect-damaged wood could be used as a combustion energy source.

AFW-9. WASTE MANAGEMENT—WASTE MANAGEMENT STRATEGIES

9.1 Advanced Recycling and Composting

Increase recycling and reduce waste generation in order to limit GHG emissions associated with landfill methane generation and with the production of raw materials. Increase recycling programs, create new recycling programs, provide incentives for the recycling of construction materials, develop markets for recycled materials, and increase average participation and recovery rates for all existing recycling programs. Establish a "scrap exchange" where used materials may be dropped off or picked up.

9.2 Expanded Use of Municipal Solid Waste and Yard Waste Biomass Feedstocks for Electricity, Heat, and Steam Production

Increase the amount of biomass available for generating electricity and displacing the use of fossil energy sources. Local electricity or steam production yields greatest net energy payoff. Note: This is related to Option 1.1: Forestry and Agriculture Biomass to Energy.

9.3 Promotion of Bioreactor Technology

A bioreactor landfill is essentially in-landfill composting activity at a Subtitle D sanitary landfill in which liquid, temperature, and air (for aerobic processes), are managed in a controlled manner to achieve rapid stabilization of the food, greenwaste, and paper-waste constituents. To optimize the rapid waste stabilization of these wastes, moisture, gas composition, gas flow, and temperature must be carefully maintained and monitored. Bioreactor technology is used to accelerate waste stabilization, enhance gas production and collection, control leaching, reduce volume, and minimize long-term liability of waste.

9.4 Source Reduction Strategies

Reduce the volume of waste from residential, commercial, and government sectors through programs that reduce the generation of wastes. Reduction of generation at the source reduces both landfill emissions and upstream production emissions. This action will reduce the amount of land taken out of productivity and dedicated to landfills, thereby increasing opportunities for terrestrial carbon sequestration.

9.5 Resource Management Contracting

Unlike traditional solid waste service contracts, resource management (RM) compensates waste contractors based on performance in achieving an organization's waste reduction goals rather than the volume of waste disposed. As a result, RM aligns waste contractor incentives with the goals to explore innovative approaches that foster cost-effective resource efficiency through prevention, recycling, and recovery. This action will reduce the amount of land taken out of productivity and dedicated to landfills thereby increasing the opportunity for terrestrial sequestration and will encourage wood recycling.

9.6 Waste Coal Recapture

Maximize the efficiency of coal by recapturing and utilizing waste coal.

9.7 Prevent Landfilling of Unprocessed Organic Material

Reduces methane emissions associated with landfilling by reducing the biodegradable fraction of waste emplaced. Recently, an area of focus in the solid waste industry has been in increasing recycling of organic wastes (e.g., lawn and garden waste, food waste, wood, paper, and bio-based plastics) using different conversion technologies, including composting, anaerobic digestion, or hybrids of these technologies.

9.8 Waste Management Feedstocks for Liquid/Gaseous Fuels Production

Use MSW biomass (waste wood, landscape debris, other fiber) to produce liquid or gaseous biofuels for use in transportation or stationary energy needs. For example, these could include cellulosic ethanol feedstocks, biomass gasification feedstocks, etc. Organic materials can be converted to biochar and safely put on soils. (Other municipal solid waste can be converted to char but that char should not be placed in soils due to potential contaminants. Therefore, only the conversion of organic biomass waste offers sequestration opportunities through biochar.)

9.9 Increase Commercial Recycling

Even in areas with strong residential recycling programs, there is often room for progress in commercial recycling. Increase commercial recycling in order to limit GHG emissions associated with landfill methane generation and with the production of raw materials. Promote commercial recycling programs, create new recycling programs, provide incentives for the recycling of construction materials, develop markets for recycled materials, and increase commercial participation and recovery rates for all existing recycling programs.

9.10 Community Collection of Food Scraps for Composting and Anaerobic Digestion

Promote programs that allow residents and commercial entities to pool food scraps and organic waste for composting or anaerobic digestion. This policy can tie in with 1.8 Installation of Community Digesters, 9.1 Advanced Recycling and Composting, and 12.9 Increase Use of Compost in Residential and Commercial Landscaping.

9.11 Establish System for Reuse or Recycling of Construction and Demolition Materials

Establish markets for construction and demolition waste. Municipalities may set the example by promoting the use of these materials in city or county projects. Establish a construction material "scrap exchange" where used materials may be dropped off or picked up.

AFW-10. WASTE MANAGEMENT—LANDFILL GAS STRATEGIES

10.1 Flare Landfill Methane at Non-NSPS (smaller) Sites

Encourage smaller landfills that do not fall under environmental protection regulations for New Source Performance Standards (NSPS) to capture and flare methane gas. Flares are used to safely combust toxic and volatile gases from landfills and they convert methane gas, which has a relatively high global warming potential, to carbon dioxide.

10.2 Methane and Biogas Energy Programs

Encourage and promote the use of anaerobic digesters and energy recapture for waste materials other than municipal solid waste at landfills (e.g., food processing waste). These projects will help prevent the emission of methane while producing clean energy. Anaerobic digesters make a two-fold contribution to climate protection: the usual unchecked discharge of methane into the atmosphere is prevented, and the burning of fossil fuels is replaced with renewable energy (biogas).

10.3 Landfill Methane Energy Programs

Use the renewable energy created at landfills by anaerobic digestion (methane) to make electric power, space heat, or liquefied natural gas.

AFW-11. WASTE MANAGEMENT—WASTEWATER MANAGEMENT ACTIVITIES

11.1 Energy Efficiency Improvements at Wastewater Treatment Facilities

Provide incentives for efficiency improvements. Encourage the setup of energy policies, energy audits, and energy cost tracking. Identify and implement energy improvements such as using energy-efficient equipment and generating on-site power (e.g., solar power).

The term "efficiency improvements" is defined, within the scope of wastewater management activities, as:

- Conversion of secondary aeration processes to fine bubble diffusion and optimization of oxygen transfer efficiencies;
- Research and development of diffuser cleaning protocols;
- Research and development to increase removal of chemical oxygen demand (COD) in primary treatment tanks and clarifiers;
- Evaluation of steam usage in plant processes and biofilters, optimization of use, and promotion of alternatives; and
- Research and development of options to optimize denitrification in secondary treatment.

Financial and performance analyses that may be conducted to assist the implementation of this option include:

- Creation of a regional or local leveraged revolving loan fund program to capitalize energy efficiency in municipal wastewater treatment plants (WWTPs).
- Conduct benchmarking of energy use per million gallons treated regionally or locally to showcase good and deficient energy performance in this specific climate.

May also include researching ways to use wastewater biomass as an energy source rather than just as a soil carbon source.

11.2 Lower Wastewater Processing Needs

Develop and implement best practices for lowering water consumption and lowering waste production in the industrial, commercial, and residential sectors. Encourage and create incentives for research and development on methods or technologies to reduce water consumption and waste production. Provide education to reduce water consumption and waste production. Lower water consumption and waste production lead to lower GHG emissions.

11.3 Install Digesters and Turbines, Engines or Fuel Cells

Provide incentives to install anaerobic digesters to treat municipal waste and create methane. Install turbines or reciprocating engines to generate electricity from the methane. Reductions occur via methane control and offsetting fossil energy use. Provide incentives to recover heat from wastewater influent or effluent through the use of heat pumps. Investigate opportunities for waste heat recovery from biogas combustion units (turbines, engines, flares).

11.4 Wastewater Treatment Plant Biosolids for Energy Production

Develop and implement methods for bio-solids processing and use as a renewable energy source. For example, as a renewable fuel to be co-fired with other fuels in existing or new combustion units for the purpose of generating electricity, heat or steam.

11.5 Algae in Waste Effluent for Biofuel Production

Provide financial incentive to research the production of bio-oils from algae or other microorganisms grown in wastewater effluents (which would reduce carbon, nitrogen, and phosphorus) and from flue gases. Algae are highly effective at storing carbon while growing.

11.6 Utilization of Biosolids as a Fertilizer Substitute

Promote the use of residual biosolids from wastewater treatment plants on farms in order to replace fossil-derived fertilizers and prevent biosolids from releasing methane if placed in landfills or carbon if left to oxidize. Residual carbon in the biosolids adds carbon to the soil while enhancing plant growth and soil carbon sequestration.

AFW-12. URBAN FORESTRY AND URBAN AGRICULTURE

12.1 Increase Residential Tree Cover

Maintain and improve the health and longevity of trees in residential areas to protect and enhance the carbon stored in tree biomass. Indirect emissions reductions may also occur by reducing heating and cooling needs as a result of planting shade trees.

12.2 Increase Commercial/Municipal Tree Cover

Promote use of software programs that can be used by cities and communities to track urban forestry. Maintain and improve the health and longevity of trees in urban areas to protect and enhance the carbon stored in tree biomass. Indirect emissions reductions may also occur by reducing heating and cooling needs as a result of planting shade trees.

12.3 Analysis of Tree Cover and Optimization of Tree Placement to Decrease Air Conditioning Needs

Utilize software applications and surveying to identify prime location for tree planting. Optimal tree placement may result in reduction of heating and cooling needs. GHG reductions occur from reductions in fuel for heating and cooling.

12.4 Increase Greenspace Acreage

Promote designation and protection of greenspace for carbon sequestration. Encourage the designation of parks and greenspaces during and after development.

12.5 Increase Carbon Sequestration in Parks and Greenspace through Improved Tree Stocking

Parks and greenspaces provide carbon sequestration in urban and suburban neighborhoods. Improvement of tree stocking in these areas can increase carbon sequestration.

12.6 Promote Community Gardens

Encourage the planting of community gardens in urban and suburban areas. Promote all forms of urban agriculture and intensification of plant density in urban settings through community gardens, backyard gardens, and green roofs. Utilize marginal, abandoned, or under-developed lands for gardening. Promote participation in urban agriculture programs that reduce GHGs by sequestering carbon and reduce cooling costs by mitigating urban heat islands. Programs also reduce transportation-related emissions by reducing food miles for urban consumers.

12.7 Promote Local Agricultural Products through Farmer's Markets

Encourage and support local and regional Farmer's Markets as a market for local products. The consumption of local agricultural products versus imported can reduce transportation-related GHG emissions through reduction in food miles – the number of miles food has to travel from production to consumption.

12.8 Protect Native Trees and Vegetation during Development

Preserve native vegetation during development, allowing established trees and vegetation to maintain their carbon sequestration. Undisturbed soil also reduces erosion risk and protects soil carbon sequestration.

12.9 Increase Use of Compost in Residential and Commercial Landscaping

Encourage use of compost in landscaping. Composting returns carbon from the organic waste stream to the soil and promotes vegetation. The use of compost also can reduce the need for watering as compost provides water retention qualities. This option can work in conjunction with waste management options focused on promotion of organics management including composting.

AFW-13. WATER MANAGEMENT

13.1 Increase Efficiency of Water Delivery Systems

Reduce GHG emissions from fuel consumed during water delivery by improving water delivery systems. Promote efficient planning of water delivery and sewer systems, improvements to existing systems, and encourage upgrading of water delivery equipment. Identify best practices in communities.

13.2 Increase Water Recycling

Reduce GHG emissions from fuel consumed during water delivery by decreasing water delivery needs. Promote systems that reuse or re-circulate water.

13.3 Increase Beneficial Use of Urban Runoff

Capture urban runoff for use in municipal or commercial watering or landscaping. Divert runoff to water storage facilities.

13.4 Improve Residential Water Use Efficiency

Encourage efficient use of water in residential systems including the use of rain barrels and drip irrigation. Encouraging lawn watering during night hours when less water will evaporate. Encourage use of appliances that consume less water. This will reduce GHG emissions from fuel consumed during water delivery by decreasing water delivery needs.

13.5 Improve Commercial/Municipal Water Use Efficiency

Encourage efficient use of water in commercial and municipal systems. Promote the use of rain barrels and drip irrigation. Encouraging lawn watering during night hours when less water will evaporate. Encourage government purchasing of appliances that consume less water. This will reduce GHG emissions from fuel consumed during water delivery by decreasing water delivery needs.